



**To:** Ann Costanza, Anchor QEA, LLC  
**From:** Kerrie McArthur and Paul Schlenger  
**Date:** December 27, 2016  
**Re:** Lund's Gulch Creek Fish Habitat Assessment

**Enclosures:** Figure 1 Lower Reach Location  
Appendix A Fish Habitat and LWD Survey Data

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## 1.0 INTRODUCTION

Several species of salmonids utilize Lund's Gulch Creek including Chinook, coho, chum, steelhead, and sea-run cutthroat trout. Currently, Lund's Gulch Creek flows through a 6-foot-wide by 7-foot-tall box culvert through the railroad embankment at the mouth of the creek. A narrow ledge in the box culvert is also the only legal access for park users to reach the beach. The box culvert does not function adequately either as the creek conduit or as a means to access the beach. The box culvert is significantly undersized for a creek system the size of Lund's Gulch Creek. As a result, creek flows are partially impounded upstream of the culvert during high flows, which causes flooding in the park and deposition of large quantities of stream sediment. The sediments accumulate in and upstream of the box culvert, resulting in impacts to creek habitat, fish movements, and park visitor access to the beach. Maintenance of this culvert by Snohomish County requires several permits and can only be performed during specific time periods ("work windows") defined in the permits. In the last several years, maintenance actions have been unable to sustain clear access for fish or people due to the excessive volume and frequency of gravel deposition within and upstream of the culvert.

Snohomish County Parks conducted a feasibility study in 2015 to evaluate restoration alternatives for the Lund's Gulch Creek estuary in Meadowdale Beach County Park. The preferred alternative has been chosen and a conceptual plan designed. This assessment was prepared to document existing fish habitat conditions in support of the restoration design and associated permitting.

## 2.0 METHODS

The following methods were used to characterize fish habitat in the lower reach of Lund's Gulch Creek. The lower reach was defined as the 760 linear feet of Lund's Gulch Creek

beginning at the upstream end of the railroad culvert to the downstream end of the foot bridge adjacent to the ranger's home (Figure 1).

## **2.1 Fish Habitat Survey**

Because no single measure of physical habitat is sufficient to describe habitat conditions in a reach, several habitat parameters were evaluated to aid in describing conditions within the lower reach of Lund's Gulch Creek. The physical habitat parameters for this assessment followed modified methods described in U.S. Forest Service's Stream Inventory Handbook – Level I & II (USFS 2003) and the Washington State Watershed Analysis Methods (WFPB 2011).

The survey area of Lund's Gulch was divided into two reaches: a lower reach encompassing the restored estuary area and an upper reach encompassing the remainder of the stream length up to the bridge near the Park Ranger's residence. The survey area was further divided into 18 segments, based on channel type. Eleven segments encompassing 308 feet upstream from the outlet culvert comprised the Restored Estuary reach and seven segments encompassing 452 feet comprised the Stream reach.

Data were collected on the length of each segment defined in the field, channel type (pool, riffle, single, multiple, etc.), flow regime, substrate (dominant, subdominant, etc.), wetted width and depth, and pool characteristics (pool former, residual pool depth) at each change in channel type. Fish observations were also recorded. Details of the data collected are below.

### **2.1.1 Channel Type**

Data was collected on the channel type of each segment. The channel type is a general characterization of the channel morphology of each segment and was categorized as either riffle or pool. The channel type was identified as pool only if the pool spanned most the channel.

### **2.1.2 Flow Regime**

Flow regime refers to perennial or intermittent flow condition. The flow regime can be classified as permanently flowing or intermittently flowing.

### **2.1.3 Substrate**

Data on substrate were collected to determine the presence and quality of spawning habitat in the lower reach of Lund's Gulch Creek for both resident and anadromous salmonids. Factors considered were dominant and subdominant substrate, spawning gravel presence, and embeddedness. These characteristics are described below.

## **Dominant and Subdominant Substrate**

The dominant and subdominant substrate were visually estimated for each segment. Observations on surface substrate size were recorded using the substrate classification codes for IFIM analysis (WDFW and Ecology 2016). This substrate classification code uses a scale of 1 to 9, with 1 representing fines (i.e., silt and clays) and 9 representing bedrock.

Substrate codes use the format “ab.c” where “a” is the component code for dominant particle size<sup>a</sup>, “b” is the component code for the subdominant particle size, and “c” is tenths of cell area covered by dominant (50% or greater) substrate type. For example, the code 46.8 indicates 80% medium gravel and 20% small cobble (WDFW and Ecology 2016).

## **Spawning Gravel Presence**

The presence of spawning gravel was determined within each segment. The presence of spawning gravel was identified for both anadromous and resident salmonids. Spawning gravel for anadromous salmonids was determined as present if there was at least one patch of suitably sized gravel (medium gravel to large cobble) that was equal to or greater than 22 square feet. Spawning gravel for resident salmonids was determined as present if there was at least one patch of suitably sized gravel (small gravel) that was equal to or greater than 3 square feet.

## **Embeddedness**

Embeddedness is defined as the degree to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Therefore, embeddedness was used to rate the quality of the spawning present.

Substrate was classified as embedded (i.e., inferring less suitable for egg incubation) if the amount of fines in the interstitial spaces was visually estimated at more than 25 percent (Flosi et al 1998).

### **2.1.4 Wetted Width and Depth**

Data on the average wetted width and depth were recorded for each segment. The average wetted depth was used to calculate residual pool depths (see below).

### **2.1.5 Pool Data**

Data on pools were collected to evaluate the quality rearing habitat in the lower reach of Lund’s Gulch Creek. Data collected for pools included information on what formed the pool and the

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<sup>a</sup> The type of substrate that covers the greatest area of bottom surface in a particular cell, not necessarily the largest-diameter particle; e.g., sand may be dominant over cobble.

residual depth of the pool. The NMFS (1996) pool quality was defined as pools greater than 3 feet in residual depth with good cover and cool water, and minor reduction of pool volume by fine sediment. This definition is best suited for large river systems, where adult salmon “hold” in these larger pools until the smaller tributaries discharge sufficient flow to trigger upstream migration and spawning in these smaller streams. Because of the relatively small size of Lund’s Gulch Creek, holding pools would not develop in the creek. Therefore, pools were defined based on the definition of pools as described in the Timber Fish and Wildlife Monitoring Program’s Method Manual for the Habitat Unit Survey (Pleus et al. 1999). For streams the size of Lund’s Gulch Creek, pools were defined as areas at least 5 square feet in size and 4 inches in residual depth (Pleus et al. 1999).

### **Pool Former**

Data were recorded on how pools were formed. Pool forming structures can include large woody debris (LWD), boulders, or other structures, such as heavily rooted banks. Identifying the pool forming structures is important in understanding what physical processes are forming fish habitat.

### **Residual Pool Depth**

Residual pool depth is the difference in depth or bed elevation between the deepest depth of a pool and the downstream riffle crest. Residual pool depth is the depth that, if flow were reduced to zero, water would fill pools just up to the downstream riffle crest. Residual depths represent extreme low flow conditions, which can limit a stream’s capacity to support fish populations.

## **2.2 Large Woody Debris Survey**

The LWD survey followed a modified method described in the Washington State Watershed Analysis Methods (WFPB 2011). NMFS (1996) defined LWD as wood larger than 24 inches diameter and more than 50 feet in length. However, this definition of LWD was too large for smaller streams like Lund’s Gulch Creek; therefore, the definition of LWD for Lund’s Gulch Creek was based of the definition described in the Washington Watershed Analysis Manual (WFPB 2011), which defined a key piece of LWD for a stream the size of Lund’s Gulch Creek as larger than 4 inches in diameter and more than 6 feet in length.

Data on location (distance from start of reach), length, diameter class (4-12 inches, 12-24 inches, etc.), recruit process, and function (scour pool, dam pool, sediment storage, etc.) were recorded for any woody debris identified as LWD.

LWD was then categorized as a key piece if the LWD met the WFPB (2011) minimum volume of 35 cubic feet. Although the overall LWD count is important, it is also important to identify key pieces that are large enough to remain in place for a significantly longer period (often even

during extreme flood events) and are more effective at trapping other smaller woody debris pieces and sediment (WFPB 2011).

## **2.3 Habitat Ratings**

Snohomish County evaluated habitat in the lower reach of Lund's Gulch Creek in 2002 as part of Snohomish County's Puget Sound Tributaries Drainage Needs Report (Snohomish 2002). The Drainage Needs Report (2002) rated habitats using a modified matrix of properly functioning habitat condition indices developed by National Marine Fisheries Service (NMFS 1996). To provide comparable ratings to the Drainage Needs Report, the habitat ratings in this report were also assigned using NMFS (1996). The NMFS habitat indices are presented in Table 1. The indicators of the pathways described in the properly functioning matrix recognize that there would be circumstances where the range of numerics in the matrix do not apply to a specific watershed or basin (NMFS 1996). Lund's Gulch Creek is such a basin because of its small size. Specifically, indicators for some pathways, such as LWD and pool frequency, were presented by NMFS (1996) as a value per mile. Because of the small size of the Lund's Gulch Creek, these values were converted to a value per 500 feet in Table 1.

Habitat ratings were evaluated for two reaches of the Lund's Gulch Creek lower reach: (1) the Restored Estuary Reach, which begins at the upstream end of the railroad culvert and goes upstream to 308 feet; and (2), the Stream Reach, which extends across the remaining 452 feet of the survey area from the Restored Estuary Reach to the foot bridge near the Park Ranger's house. These two reaches were rated separately because of the different restoration options being proposed for the two reaches.

**Table 1. Habitat Ratings Modified from NMFS (1996)**

Pathway	Indicators	Properly Functioning (good habitat)	At Risk (fair habitat)	Not Properly Functioning (poor habitat)
<b>Habitat Access:</b>	<b>Physical Barriers</b>	any man-made barriers present in watershed allow upstream and downstream fish passage at all flows	any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at base/low flows	any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows

<b>Habitat Elements:</b>	<b>Substrate</b>	dominant substrate is gravel or cobble (interstitial spaces clear), or embeddedness <20% <sup>a</sup>	gravel and cobble is subdominant, or if dominant, embeddedness 20-30% <sup>a</sup>	bedrock, sand, silt or small gravel dominant, or if gravel and cobble dominant, embeddedness >30% <sup>b</sup>
	<b>Pool Frequency</b>  channel width      # pools per 500 ft. <sup>c</sup> 5 ft.                      17.4 10 ft.                    9.1 15 ft.                    6.6 20 ft.                    5.3	meets pool frequency standards (left) and LWD recruitment standards for properly functioning habitat (below)	meets pool frequency standards but LWD recruitment inadequate to maintain pools over time	does not meet pool frequency standards
	<b>Pool Quality<sup>d</sup></b>	most pools at least 5 square feet in size and 4 inches in residual depth with good cover and cool water <sup>a</sup> ; minor reduction of pool volume by fine sediment	few pools (> 5 square feet and 4 inches) present or inadequate cover/temperature <sup>a</sup> ; moderate reduction of pool volume by fine sediment	no pools (5 square feet and 4 inches) and inadequate cover/temperature <sup>a</sup> ; major reduction of pool volume by fine sediment
	<b>Large Woody Debris</b>	>7.57 pieces/500 ft., >4 inches diameter, >6 ft. length <sup>a</sup> , and adequate sources of woody debris	currently meets standards for properly functioning, but lacks potential sources from riparian areas of woody debris recruitment to	does not meet standards for properly functioning and lacks potential LWD recruitment

<sup>a</sup> WFPB 2011

<sup>b</sup> Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. National Marine Fisheries Service, Northwest Region, March 1, 1995.

<sup>c</sup> Biological Opinion on Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). National Marine Fisheries Service, Northwest Region, January 23, 1995.

<sup>d</sup> Pleus et al. 1999

		recruitment in riparian areas	maintain that standard	
	<b>Off-Channel Habitat</b>	backwaters with cover, and low energy off-channel areas (ponds, oxbows, etc.) <sup>a</sup>	some backwaters and high energy side channels <sup>a</sup>	few or no backwaters, no off-channel ponds <sup>a</sup>

### 3.0 RESULTS

Results of the Lund's Gulch Creek habitat assessment are presented below and summarized in Table 2. Appendix A provides tables detailing fish habitat and LWD data collected.

**Table 2. Habitat Assessment Summary**

Pathway	Indicator	Restored Estuary Reach		Stream Reach	
		Survey Results	Habitat Rating	Survey Results	Habitat Rating
<b>Habitat Access</b>	Physical Barriers	Barriers absent	Properly Functioning	Barriers absent	Properly Functioning
<b>Habitat Element: Spawning and Incubation</b>	Substrate	89% of total length of reach was spawning habitat, 63% of which was embedded with sand	Not Properly Functioning	92% of total length of reach was spawning habitat, 88% of which was embedded with sand	Not Properly Functioning
<b>Habitat Element: Rearing</b>	Pools	Pool frequency was 16.2 pools per 500 feet, but lacked cover	At Risk	Pool frequency was 8.8 pools per 500 feet, but lacked cover	At Risk
		Residual pool depths were greater than 4 inches	Properly Functioning	Residual pool depths were greater than 4 inches	Properly Functioning
	LWD	30.8 pieces per 500 feet	Properly Functioning	44 pieces per 500 feet	Properly Functioning
	Off-Channel	No off-channel habitat exists	Not Properly Functioning	No off-channel habitat exists	Not Properly Functioning

#### 3.1 Habitat Access

Habitat access was rated based on the presence or absence of fish migration barriers. No physical barriers were present in the Restored Estuary or Stream reaches; thus, this pathway is considered Properly Functioning for both reaches.

## **3.2 Spawning and Incubation Habitat**

Spawning and incubation habitat was rated based on the quantity and quality of substrate of the appropriate size for spawning. Substrate was dominated mostly by gravels throughout the reach.

In the Restored Estuary Reach, approximately 89 percent of the stream channel by length (274 feet out of 308 feet) contained gravel sizes suitable for anadromous salmon spawning habitat; however, 63 percent of the available spawning habitat by length was embedded (173 feet out of 274 feet). Overall, 37 percent of the stream channel in the Restored Estuary Reach provided suitably sized spawning substrate that was not embedded. These conditions correspond to a Not Properly Functioning rating for the Restored Estuary Reach.

In the Stream Reach, approximately 92 percent of the stream channel by length (414 feet out of 452 feet) contained gravel sizes suitable for anadromous salmon spawning habitat; however, 88 percent of the available spawning habitat by length was embedded (363 feet out of 414 feet). Overall, 12 percent of the stream channel in the Stream Reach provided suitably sized spawning substrate that was not embedded. These conditions correspond to a Not Properly Functioning rating for the Stream Reach.

## **3.3 Rearing Habitat**

Summer and winter rearing habitat was rated based on pool frequency and LWD quantity, and the presence or absence of off-channel habitat.

### **3.3.1 Pools**

The channel width of Lund's Gulch Creek ranged from 5 to 20 feet, depending on location. Based on an average channel width of 10 feet, 9.1 pools per 500 feet of stream was needed to be rated as Properly Functioning.

Eighteen pools were observed in the survey reach. Of the 18 pools, 10 were located within the Restored Estuary Reach and eight pools in the Stream Reach. Pools were primarily formed as scour or dam pools by LWD or a combination of LWD and boulders. In the Restored Estuary Reach, pool frequency was calculated at 10 pools per 308 feet or 16.2 pools per 500 feet. In the Stream Reach, pool frequency was calculated at eight pools per 452 feet or 8.8 pools per 500 feet. Both the Restored Estuary and the Restored Stream reaches met the pool frequency standards. In addition, while pools were formed primarily by LWD, the LWD was providing little to no cover in the pools, as the LWD lacked structures such as branches or root wads that would provide cover. Thus, the pool frequency was rated as At Risk for both the Restored Estuary or Stream reaches.

The residual depths of pools were mostly less than 6 inches deep, but greater than 4 inches deep, with four pools (two in the Restored Estuary Reach and two in the Stream Reach) having a residual depth of 6 to 12 inches deep and two pools (one in the Restored Estuary Reach and one in the Stream Reach) having a residual depth of 12 to 24 inches deep. All residual pools depths were greater than 4 inches deep; thus, the pool quality in both reaches was rated at Properly Functioning.

### **3.3.1      *Large Woody Debris***

LWD in the survey reach was inventoried by counting the number of pieces, identifying the recruitment process delivering the LWD to the creek, the influence zone of each piece, and the functions provided by each piece of LWD. Only the LWD count was used in the habitat rating.

LWD was rated based on the quantity of LWD per 500 feet. A total of 59 pieces of LWD were surveyed in the lower reach, of which 19 pieces of LWD were located within the Restored Estuary Reach (extrapolated to 30.8 pieces of LWD per 500 feet). Of these 19 pieces of LWD, five were classified as a key piece (extrapolated to eight pieces of LWD per 500 feet). A total of 40 pieces of LWD were located within the Stream Reach (extrapolated to 44 pieces of LWD per 500 feet). Of these 40 pieces of LWD, 23 were large enough to be identified as a key piece (extrapolated to 25 pieces of LWD per 500 feet). Thus, the LWD was rated as Properly Functioning for both reaches.

In addition to counting each individual piece of LWD in the lower reach, LWD pieces were recorded as being located within a log jam or not (jam or inner jam zones) (Hart Crowser 2000). A majority (38) of LWD pieces were not part of log jams; rather, they were lone pieces scattered throughout the survey reach (i.e., located in the inner jam zone), providing minimal habitat features and small residual pool depths. Enhancement structures, defined as LWD with clean cut ends placed for enhancement purposes, accounted for 36 pieces. Another 22 pieces of LWD were identified as being naturally recruited into the stream channel by windthrow and five pieces naturally recruited by bank erosion. This indicated that the dominant recruitment process for LWD besides placement for habitat enhancement was by windthrow.

In addition to identifying the recruitment process of each piece of LWD, the influence zone of each piece was recorded. The influence zone was defined as the LWD being within or above the banks of the creek. This allowed us to evaluate if the LWD was currently functioning to alter the stream habitat or had the potential to do so. That is, LWD within creek banks was currently performing some function, although it may only be functioning during specific flow range (recorded as partially functioning). LWD located above creek banks was not currently performing any habitat function, but could once it drops within creek banks, either naturally or by human activity. Eight pieces were identified as being above the influence zone and therefore were not providing any habitat-forming functions at the time of the survey.

The function provided by each LWD piece was also recorded. Functions included

- scour pool creation,
- dam pool creation,
- sediment storage, and
- wood steps.

Most LWD formed scour pools downstream of the LWD and provided sediment storage upstream of the LWD. However, 25 of the 59 pieces/jams were providing partial to no function, typically due to their orientation in the stream channel (e.g., parallel to stream flow to provide some cover function, but no habitat-forming function).

### **3.3.2 Off-Channel Habitat**

Off-channel habitat provides winter rearing habitat, especially for coho salmon (WFPB 2011). Off-channel habitat was rated based on the presence of backwater or low-energy off-channel areas with cover. No backwater or accessible off-channel habitat was observed in the lower reach; thus, this pathway is Not Properly Functioning. Adjacent to the Stream Reach, there is a man-made shallow pond. However, the connection between the pond and the creek was not sufficiently defined so that the pond could be considered as providing off-channel habitat.

## **4.0 SUMMARY**

The fish habitat and LWD survey assessed various pathways and indicators to determine if the pathways were functioning properly. The assessment found conditions in Lund's Gulch Creek within the lower reach to be suitable for specific pathways.

Within the Restored Estuary Reach, the existing stream channel is dominated by substrates suitable for anadromous and resident fish spawning but is not properly functioning due to sedimentation. Because of the large quantity of LWD (including key pieces) within the lower reach, the function of the LWD is providing sufficient rearing habitat. Pool frequency and pool quality, important habitat features for rearing juvenile salmon, were determined to be at risk due to the lack of pool cover provided by LWD.

Similar to the Restored Estuary Reach, the existing stream channel in the Stream Reach is dominated by substrates suitable for anadromous and resident fish spawning but is not properly functioning due to sedimentation. Pool frequency and pool quality were determined to be at risk due to the lack of pool cover provided by LWD, despite the large quantity of LWD (including key pieces) within the Stream Reach.

A geomorphic study is recommended to determine if the sediment load into the lower reach is greater than the capacity of the enhancement structures to store the sediment, thus filling in the

existing pools, or could prevent the creation of new pools. Depending on the results of the geomorphic study, strategic repositioning of LWD either currently located above bankfull depth or parallel to stream flow could result in additional pool formation or the deepening of residual pool depths of existing pools. In addition, enhancing the connection between the existing man-made pond adjacent to the Stream Reach, would provide off-channel rearing habitat.

## 5.0 REFERENCES

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